unetched surface and thereby create an etched surface having voids between said particles, wherein said nitrogen will not react with said substrate and will not change the oxidation state of said substrate during removal of said portion of said binder phase; and

applying a coating to at least a portion of said substrate so that said coating is at least partially disposed within at least a portion of said voids.

REMARKS

Claims 30 and 39-48 are pending In the subject application. In the Office Action, claims 30 and 39-48 are rejected. Claim 30 has been cancelled and new claim 49 has been added. Support for new claim 49 may be found in original claims 20 and 30 and elsewhere in the specification as filed. Applicants herein submit amendments and the following remarks which overcome the rejections.

Claim Rejections under 35 U.S.C. § 112, second paragraph

In paragraph 2, claims 30 and 43 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to point out and distinctly claim the subject matter which Applicants regard as the invention. In response to these rejections, Applicants submit the following:

- Claim 30 stands rejected as being dependent on a cancelled claim. In response, claim 30 has been cancelled and replaced with independent claim 49, including all limitations of the original claim 30 and original claim 20.

- Applicants disagree with the Examiner that the terms "molybdenum-containing" and "tungsten-containing" are indefinite as used in claim 43. For example, one skilled in the art would readily understand that a molybdenum-containing material is a material comprising molybdenum. However, in order to advance prosecution of the claims, Applicants herein amend claim 43 to restate, without narrowing the scope of the claim, the limitation as a "material comprising molybdenum" and a "material comprising tungsten".

Accordingly, withdrawal of the rejection under 35 U.S.C. § 112, second paragraph, of claims 30 and 43 and reconsideration of claim 43 are respectfully requested.

Claim 48 is rejected under 35 U.S.C. § 112, second paragraph, because in the Examiner's opinion a claim comprising a Markush group is indefinite if the groups listed within the Markush group are of varying scope such that the narrow range or limitation falls within the broad range. The Examiner cites several cases to support this proposition, primarily relying on *Ex parte Wu*, 10 U.S.P.Q.2d 2031, 2033 (Bd. Pat. App. & Inter. 1989).

As held in *Ex parte Wu*, "In rejecting a claim under the second paragraph of 35 USC 112, it is incumbent on the examiner to establish that one of ordinary skill in the pertinent art, when reading the claims in light of the supporting specification, would not have been able to ascertain with a reasonable degree of precision and particularity the particular area set out and circumscribed by the claims." *Wu* at 2033 citing *In re Moore*, 439 F.2d 1232, 169 U.S.P.Q. (CCPA 1971) and *In re Hammack*, 427 F.2d

1378, 166 U.S.P.Q. (CCPA 1970). The Board in *Wu* continued, stating that "[t]he use of the term "such as" can render a claim indefinite by raising a question or doubt as to whether the feature introduced by such language is (a) merely exemplary of the remainder of the claim, and therefore not required, or (b) a required feature of the claim."

Applicants respectfully submit that the Markush group of claim 48, which in the Examiner's opinion recites a broad recitation of devices and recites particular devices within the same area, does not raise a question or doubt as to whether the feature is merely exemplary or a required feature of the claim. Accepted U.S. patent practice is for each element of the Markush group to be considered individually and in the alternative (e.g. wherein the object of claim 48 may be, for example, a drilling device or the object of claim 48 may be a drill bit). The objected to limitation of claim 48 does not create the doubt referred to in *Wu*.

Additionally, the Manual of Patent Examining Procedure ("MPEP") § 2173.05(h) clearly states:

> The double inclusion of an element by members of a Markush group is not, in itself, sufficient basis for objection to or rejection of claims. Rather, the facts in each case must be evaluated to determine whether or not the multiple inclusion of one or more elements in a claim renders that claim indefinite. The mere fact that a compound may be embraced by more than one member of a Markush group recited in the claim does not necessarily render the scope of the claim unclear. For example, the Markush group, "selected from the group consisting of amino, halogen, nitro, chloro and alkyl" should be acceptable even though "halogen" is generic to "chloro."

The recitation in claim 48 is similar to the acceptable example set forth in § 2173.05(h) of the MPEP and therefore should also be acceptable. The Examiner rejects the claim

of the subject application because the listing in the Markush group of claim 48 includes a generic term, for example, "drilling devices", and a specific term, "drill bits". Applicants respectfully disagree that claim 48 is indefinite based on the clearly relevant and specific recitations of the MPEP and the failure of any cited language in a statute, rule, or case law to specifically or inferentially contradict the specific recitation of the MPEP. Reconsideration of the rejection of claim 48 under §112, second paragraph, is respectfully requested.

Claim Rejections under 35 U.S.C. § 102

Claims 30, 39-48 are rejected under 35 U.S.C. § 102 as being anticipated by various issued patents. Applicants respectfully disagree that the disclosure of the cited patents anticipate the product claims of the subject application, and request reconsideration of claims 30 and 39-48.

The claims of the subject application are directed to a object comprising particles of a hard constituent material and a binder material. The binder material joins together the particles of the hard constituent material. The object of the subject application has at least a portion of the binder phase removed to produce an etched surface portion having voids between the particles. A coating is adhered to at least a portion of the etched surface portion of the substrate and at least a portion of the coating is deposited within at least a portion of the voids. The claims recite that voids are created in an unetched surface portion of the substrate by removing the binder material from between particles of the hard constituent material, allowing the subsequent coating to infiltrate and replace the binder material in at least a portion of the voids in the substrate. This infiltration has been found to promote and enhance

adhesion of the coating to the substrate. It has been found that the enhanced adhesion between coating and composite material substrates achieved by the present method reduces differences in thermal expansion between the substrates and coatings, improves the coating's resistance to deformation, increases coating wear resistance, and reduces the occurrence of thermal cracking.

The claims of the present invention recite the formation of a substrate with a coating that is significantly different than any of the prior art coated substrates. The differences in the process produce a physically different product with significantly different physical properties that affect the adherence of the coating in significantly different ways.

The pending claims in the subject application stand rejected based on seven references which in the Examiner's opinion anticipate the pending claims under either 35 U.S.C. § 102 (b) or (e). Applicant respectfully submit that these references disclose significantly different coated substrates and their methods of formation. Applicants herein discuss the differences. All citations refer to the prior art reference unless otherwise stated.

U. S. Patent No. 5,891,522 issued to Olson ("Olson")

Olson discloses a process for coating a tungsten carbide base material substrate with CVD diamond film including the carburization and gas-assisted vaporization of cobalt from the surface with simultaneous recrystallization of surface grains of tungsten carbide to change their stoichiometry for improved adherence. *See Abstract.* The disclosure of Olson specifically distinguishes the surface structure of the Olson product from the product produced by the methods claimed in the subject

application. As disclosed at column *3*, lines *54-56*, Olson teaches, "However, unlike techniques which remove the binder phase to some depth below the exposed WC-Co substrate surface, binder phase removal is done in a way which limits removal to only an area directly exposed to the CVD growth species, herein referred to as the 'free surface.' The phase composition of the WC phase is controlled to maximize the density of direct chemical bonding between the diamond film and the substrate."

The process of Olson is said to "a) vaporize the free surface binder phase, b) induce growth of the WC grains at the free surface, and c) shift the stoichiometery [sic] of the free surface WC phase to a carbon deficient ratio without formation of the of the [sic] brittle eta phase of WC (M_6C, $M_{12}C$)." *See column 4, lines 24 - 31.* This process promotes the recrystallization and grain growth of WC at the surface of the substrate. *See column 5, lines 2 - 3.* The process of Olson produces a free surface of the substrate "essentially free of the cobalt binder phase." The claimed object is formed by a method that does not cause recrystallization and an enlargement of the WC crystals in the composite material. The Olson method enhances adhesion in an object in a primarily chemical mechanism. In contrast, the claims of the present invention recite a method to enhance adhesion in an object in a primarily mechanical or physical mechanism through removal of the binder material from the surface portion and from between the particles.

U. S. Patent No. 5,700,518 issued to Lee et al. ("Lee")

Lee discloses a method of producing a coated composite material substrate that comprises first etching of the hard constituent of the composite material by an electrolytic etching process or a liquid chemical etching. *See column 2, lines 45 -*

59. In a cemented carbide object, this method produces a substrate wherein the "carbide phase of the cemented carbide is irregularly etched". *See column 2, lines 62 - 66.* Subsequently, the substrate is further etched "resulting in the removal of the cobalt binder phase". *See column 3, lines 3 - 6.*

The process of the subject application produces a significantly different substrate than the substrate disclosed in Lee. As set forth in the claims, the process of the subject application etches only the binder phase of the composite material. This can readily be seen in figures included in the subject application, specifically in Figures 1, and 11(a)-(d). As recited in the claims, the binder layer is specifically etched to create voids that the coating may subsequently infiltrate. Accordingly, the process of the subject application creates a patently distinct product than the product with etched hard constituent material disclosed in Lee.

U. S. Patent No. 5,560,839 issued to Bennett et al. ("Bennett")

Bennett discloses a method of producing a coated composite material substrate that comprises a first etching of the binder material and a second etching to remove the tungsten carbide to a desired depth. *See column 5, lines 21-28.*

As described above, the substrate produced by the process of the subject application has a substantially intact carbide phase through a process that removes a portion of the binder material from the surface and from between the particles. Thereafter, the coating infiltrates at least a portion of the voids created by the binder removal process. Therefore, the process of the subject application creates a patently distinct product from the product disclosed in Bennett.

U. S. Patent No. 5,415,674 issued to Feisrtritzer et al. ("Feisrtritzer")

Feisrtritzer discloses a method of producing a coated composite material substrate that comprises creating at the substrate surface, via the presence of dissociated hydrogen, conditions resulting in the thermal evaporation of binder metal. This thermal evaporation of the binder material creates temperatures at the surface of the substrate of "about 3000°C. However, diffusion and phase changes in cemented materials can no longer be neglected from temperatures of 900° and above." *See column 4, lines 38-39.* The high temperature at the surface results in "recrystallizing, in addition to and simultaneously with the evaporation of binder metal, the hard material remaining in the boundary zone whereby the substrate surface is restructured and roughened." *See column 3, lines 18-21.*

The Feisrtritzer thermal process of evaporation of the binder metal causes material changes to the surface of the substrate that do not occur in the etching process of the present invention. Particularly, The surface of the substrate in Feisrtritzer is roughened by the restructuring and recrystallization of the hard constituent material in the boundary zone. The hard constituent of the substrate of the subject application is not significantly recrystallized; rather, as recited in the claims, the roughening of the surface is due to the etching of the softer binder material to create voids between the hard constituent material.

U. S. Patent No. 5,380,408 issued to Svensson ("Svensson")

Svensson discloses a method of producing a coated composite material substrate that has been processed so that the "cobalt layer on the surface will be effectively removed whereas the cobalt in the channels between the hard material

grains will not be etched away. The binder phase layers between the carbide grains, which are necessary for the strength of the cemented carbide are not affected." *See column 2, lines 39-45.*

The method and resultant product of Svensson produces the opposite result and structure of the substrate etched by the method of the claims of the subject application. As discussed above, the claims of the present invention recite a process wherein the binder phase of the composite material is etched from the surface *and* between the hard constituent phase particles. The voids created in the substrate of the subject application can readily be seen in figures included in the subject application, specifically in Figures 1, and 11(a)-(d). The binder layer is specifically etched to create voids between the carbide particles that the coating may subsequently at least partially infiltrate.

U. S. Patents No. 5,567,526 and 5236,724 issued to Peters et al. ("Peters")

Peters discloses a method of producing a coated composite material substrate that has a surface layer of hard constituent removed and only some of the binder material removed. *See column 3, lines 23-41.* Peters describes a process that is said to increase the adhesion of an applied coating to a composite material substrate by removal of the surface carbide, or hard constituent material. The process of Peters comprises two etching steps. The first etch "removes a small amount of the tungsten carbide at the surface of the substrate while leaving the cobalt binder substantially intact. The substrate is then subjected to a process which removes any residue remaining on the surface as a result of the performance of the process which removes

the tungsten carbide." *See column 2, lines 57-62.* The primary purpose of this process appears to be the etching of the tungsten carbide and removal of the residue of this process. A by-product of the Peters process is the removal of "some" of the binder material.

The substrate produced by the method of the subject is patently distinct from the substrate produced by the process of Peters. As recited in the claims, the particles of hard constituent phase in the substrate of the present invention are left substantially intact and the binder material is removed from an unetched surface portion of the substrate to produce an etched surface portion having voids between the particles. The coating is applied to at least partially infiltrate the voids. This process and the resultant substrate are clearly distinct from the teachings of Peters.

CONCLUSION

For the reasons discussed above, none of the cited references teach an object formed by the method recited in claims 30 and 39-48. The claims of the present invention recite the formation of a substrate with a coating that is significantly different than any of the prior art coated substrates. The differences in the process produce a physically different product with significantly different physical properties that affect the adherence of the coating in significantly different ways. Accordingly, withdrawal of the rejection under 35 U.S.C. § 102 for each reference and reconsideration of these claims are respectfully requested. Furthermore, it is asserted that based on the clear distinctions between the claims of the present inventor and the references set forth above, no reference cited by the Examiner suggests an object formed by the recited

method. Accordingly, it is respectfully submitted that the claims cannot be said to be rendered obvious by the teachings of the cited references. In view of the foregoing amendments, Applicants respectfully submit that the subject application is in condition for allowance. Such action at an early date is respectfully requested. Should the Examiner have any remaining concerns regarding the application's claims, he is requested to contact the undersigned at the telephone number below so that those concerns may be addressed in an interview with the Examiner. In addition, should the Examiner deem that there remain grounds outstanding for objecting to the subject application, as amended herein, Applicants respectfully request reconsideration and allowance of all claims 30 and 39-49.

Respectfully submitted,

Patrick J. Viccaro
Registration No. 27,842

Allegheny Technologies Incorporated
1000 Six PPG Place
Pittsburgh, PA 15222-5479
Telephone: 412/394-2839
Fax: 412/394-3010

Claims of the Application Serial No. 09/627,801 indicating Amendments

40. (Amended) An object produced by a method comprising:

providing a substrate comprised of a composite material, said composite material comprising particles of a hard constituent material and a binder material, said binder material joining together said particles of said hard constituent material, said substrate further comprising an unetched surface portion; ~~having voids thereon provided by~~

removing a portion of said binder material from said unetched surface portion to produce an etched surface portion having voids between said particles, ~~said portion of said binder material being removed from said surface portion~~ by contacting said unetched surface portion with concurrent flows of at least a first gas and a second gas, said first gas capable of removing said binder material from said substrate, said second gas incapable of reacting with said substrate or changing the oxidation state of said substrate during removal of said portion of said binder material; and

adhering a coating ~~adhered~~ to at least a portion of said etched surface portion of said substrate, at least a portion of said coating being deposited within at least a portion of said voids, said voids lacking eta phase deposits therein.

43. (Amended) The object of claim 39 wherein said hard constituent material comprises one or more materials selected from the group consisting of:

a carbide material selected from the group consisting of tungsten carbide, titanium carbide, tantalum carbide, niobium carbide, vanadium carbide, chromium carbide, molybdenum carbide, and iron carbide;

a carbonitride of a refractory metal;

a nitride of a refractory metal;

a carbonitride of an element selected from the group consisting of W, Ti, Ta, Nb, V, Cr, Mo, and Fe;

an oxide of an element selected from the group consisting of aluminum, zirconium, and magnesium;

a boride of an element selected from the group consisting of aluminum, zirconium, and magnesium; ~~and~~

~~a material selected from the group consisting of tungsten,~~ a material comprising molybdenum; ~~containing material,~~ and

a material comprising tungsten ~~containing material~~.

45. (Amended) The object of claim 39 wherein said hard constituent material of said substrate comprises WC, said binder ~~phase~~ material comprises cobalt, said first gas comprises hydrogen chloride gas, and said second gas comprises nitrogen gas.

47. (Amended) The object of claim 39 wherein said coating enhances the wear resistance of said substrate and is comprised of one or more materials selected from the group consisting of TiC, TiN, TiCN, diamond, Al_2O_3, TiAlN, HfN, HfCN, HfC, ZrN, ZrC, ZrCN, ~~BC, Ti_2B, MoS,~~ Cr_3C_2, CrN, and CrCN~~, and CN~~.